

Data storage medium

5 The invention relates to a data storage medium having an optical information carrier which comprises a spiral-wound polymer film.

10 DE 298 16 802 describes a data storage medium having an information carrier, wound in a plurality of plies onto a winding core in a spiral fashion, for optically readable information units. The information carrier may comprise a polymer film, with an adhesion layer being located between each pair of adjacent plies. Information can be written to this data storage medium by locally heating the polymer film by means of a write beam of a data drive, as a result of which the refractive index and thus the reflecting power (reflectivity) change locally at the interface of the polymer film. This may be detected by means of a read beam in the data drive. By focussing the write beam or read beam, information may be specifically written to or read from a preselected ply of the information carrier. The winding core may be optically transparent and may have a recess in its central area that serves to accommodate the read/write device of a data drive.

20 The read/write device is moved relative to the data storage medium, while the data storage medium is stationary, so that the data storage medium need not be balanced to take account of a rapid rotational motion.

30 In the existing data storage medium, the winding core is a disruptive factor, since its optical quality is inadequate unless it is manufactured with a high degree of elaborateness. Since, when the data storage medium is used in a data drive whose read/write device is situated in the recess of the winding core, the winding core is required to transmit a beam a number of times during each read operation, inadequate optical quality has particularly unfavorable consequences.

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It is an object of the invention to improve the existing data storage medium such that no problems arise as a consequence of inadequate optical quality of a winding core and yet the data storage medium can be
5 manufactured economically.

This object is achieved by means of a data storage medium having the features of claim 1. Claim 7
10 specifies a process for producing a data storage medium of this kind. Claim 9 relates to the use of such a data storage medium in a drive that is attuned to it. Advantageous embodiments of the invention follow from the dependent claims.

15 The data storage medium of the invention has an optical information carrier which comprises a spiral-wound polymer film. The central area of the data storage medium is provided with a recess whose periphery is
20 formed by the innermost winding of the polymer film. Accordingly, the data storage medium contains no separate winding core such as is the case with the existing data storage medium.

25 The reading of information or data from the data storage medium of the invention and - if the data storage medium is set up for the input of data by the user - the writing of information to the data storage medium is therefore not hindered by a winding core.
30 Accordingly, the data storage medium of the invention is particularly suitable for use in a drive in which a read device and an optional write device are arranged in the recess in the central area of the data storage medium.

35 Preferably, the polymer film is wound in a plurality of polymer film plies through which information can be read from a preselected polymer film ply and, optionally, can be written to a preselected polymer

10030474-022002

film ply. There may be an adhesion layer between each pair of adjacent polymer film plies in order to fix the polymer film plies to one another. For example, from 10 to 30 polymer film plies may be wound atop one another, or else a greater or lesser number. At a polymer film thickness of between 10 μm and 100 μm , preferably below 50 μm or around 35 μm , the information on different polymer film plies can be separated from one another with good resolution by means, for example, of read/write devices which are known from DVD technology. An adhesion layer may, for example, have a thickness in the range between 1 μm and 40 μm , preferably below 25 μm or around 2 μm . A suitable adhesion agent comprises, for example, an acrylate adhesive which is free from air bubbles and which is crosslinked, for example, chemically or by irradiation with UV or electron beams. With a multi-ply data storage medium construction of this kind, it is possible to achieve a very high storage density. Furthermore, even without a winding core, the mechanical stability is sufficient and may be increased further, for example, by inserting the data storage medium into an outer sleeve. Slight deviations of the wound polymer film from an ideal spiral form, such as might arise, for example, in the absence of a winding core by deformation of the windings of the polymer film, are not disruptive to the reading and/or writing of data, since the focus of a read beam and/or of a write beam may be tracked without any problems in order to remain in a preselected ply of the information carrier. If the read device and the optional write device are disposed in the recess in the central area of the data storage medium and are moved relative to the data storage medium in order to read and/or write information, while the data storage medium is stationary, even any possible imbalance in the data storage medium is irrelevant.

Preferably, the refractive index of the adhesion layer differs only slightly from the refractive index of the

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polymer film, in order to minimize disruptive reflections of the read beam or of the write beam at a boundary between a polymer film ply and an adjacent adhesion layer. It is particularly advantageous if the
5 difference in the refractive indices is less than 0.005. Any difference in the refractive indices may, however, be utilized for the purpose of formatting the data storage medium.

10 In one preferred embodiment of the data storage medium of the invention, the refractive index of the polymer film can be changed locally by heating. Suitable material for the polymer film comprises, for example, polymethyl methacrylate (PMMA) or biaxially oriented
15 polypropylene (BOPP). If polypropylene, following extrusion to the film, is pretensioned in two planes, a high inherent energy is stored in the material. In the case of local heating, by means of a write beam, for example, there is a severe change in the material by
20 reformation, and this is so even when a relatively small amount of energy is deposited per unit area. In this way it is possible, for example, to achieve a change in refractive index of approximately 0.2 over an area for one stored information unit with a diameter or
25 side length of approximately 1 μm , and this is readily detectable by means of a read beam.

The polymer film may be assigned an absorber which is set up at least partly to absorb a write beam and to
30 emit the generated heat at least partly, locally, to the polymer film. The absorber comprises, for example, dye molecules which are present in the polymer film or in an adhesion layer adjacent to the polymer film, and permits local heating of the polymer film, sufficient
35 to change the refractive index, for a relatively low write beam intensity.

The data storage medium of the invention may be produced by winding the polymer film spirally onto a

10030474-022002

winding body and subsequently withdrawing the winding body from the central area of the data storage medium. If there is to be an adhesion layer between each pair of adjacent polymer film plies, then in one
5 advantageous embodiment of the process the polymer film is provided on one side with an adhesion layer which faces outward when the polymer film is wound onto the winding body. The adhesion layer is therefore unable to bond to the winding body, so that at the end of the
10 winding operation the winding body can be withdrawn without any problems from the central area of the data storage medium. When the winding operation has been concluded, the outward-facing adhesion layer on the outermost polymer film ply may be covered with an
15 additional, nonadhering material ply or else, for example, may be removed by means of a solvent or rendered nonadhesive by chemical or physical treatment. In this way, a data storage medium of the invention can be produced economically.

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In the text below, the invention is elucidated further with reference to embodiment examples. The drawings show, in

25 Figure 1, a data storage medium of the invention which comprises a spiral-wound polymer film, in diagrammatic perspective representation, parts of a drive attuned to the data storage medium being arranged in a recess in the
30 central area of the data storage medium;

Figure 2, a diagrammatic side view of a process step in the production of a data storage medium of the invention,

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Figure 3, a diagrammatic cross section through the central area of a data storage medium of the invention, and

Figure 4, a diagrammatic cross section through the central area of a data storage medium of the invention in the course of a process step according to another embodiment of the production process.

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10 Figure 1 shows in diagrammatic representation a data storage medium 1 and a read/write device 2 of a drive attuned to the data storage medium 1. The data storage medium 1 comprises a number of plies 10 of a polymer film 11 which serves as information carrier and is wound spirally. The design of the central area of the data storage medium 1 is described in more detail later on with reference to figure 3. For ease of illustration, the individual plies 10 of the polymer film 11 have been shown in figure 1 as concentric rings, although the plies 10 were formed by spiral winding of the polymer film 11. Between each pair of adjacent plies 10 of the polymer film 11 there is an adhesion layer 12. For reasons of clarity, the adhesion layers 12 have been drawn in figure 1 in an increased thickness which is not to scale.

25 In the embodiment example, the polymer film 11 consists of biaxially oriented polypropylene and has been pretensioned in both surface directions prior to winding. In the embodiment example, the polymer film 11 has a thickness of 35 μm ; other thicknesses in the range from 10 μm to 100 μm or even thicknesses lying outside of this range are likewise conceivable. The adhesion layers 12 are free from gas bubbles and in the embodiment example consist of acrylate adhesive, to which an absorber dye has been admixed, at a thickness of 23 μm , preferred layer thicknesses being between 30 1 μm and 40 μm . In the embodiment example, the data storage medium 1 contains twenty plies 10 of the polymer film 11 and has an external diameter of approximately 30 mm. Its height is 19 mm. A different number of plies 10, or different dimensions, are

likewise possible. The number of windings or plies 10 may, for example, be between ten and thirty, or else may be greater than thirty.

5 The read/write device 2 arranged in a recess in the central area of the data storage medium 1 comprises a read/write head 20 which can be moved backward and forward axially and rotated in the directions of the arrows that have been drawn in, by means of a
10 mechanism 21. The read/write head 20 has optical elements by means of which a light beam (of wavelength, for example, 630 nm or 532 nm) produced by a laser, which is not shown in figure 1, may be focussed onto the individual plies 10 of the polymer film 11. Since
15 the read/write head 20 is moved by means of the mechanism 21, it is able to scan fully all plies 10 of the data storage medium 1. In the embodiment example, the data storage medium 1 is stationary. Consequently, it does not need to be balanced to take account of a
20 high rotational speed (and also need not be unwound or rewound), unlike the read/write head 20. For the sake of clarity, the elements provided for balancing the read/write head 20 have not been shown in figure 1. The laser mentioned is located outside of the read/write
25 head 20 and is stationary; the laser beam is guided into the read/write head 20 via optical elements.

In the embodiment example, the laser is operated with a beam power of approximately 1 mW for the purpose of
30 storing or writing information to the data storage medium 1. The laser beam serves here as a write beam and is focussed onto a preselected ply 10 of the polymer film 11, in such a way that the beam spot is smaller than 1 μm , the light energy being introduced in
35 the form of short pulses of approximately 10 μs in duration. The energy of the write beam is absorbed in the beam spot, promoted by the absorber in the adjacent adhesion layer 12, leading to a local heating of the polymer film 11 and thus to a local change in the

refractive index and in the reflectivity.

In order to read stored information from the data storage medium 1, the laser is operated in continuous wave mode (CW mode). The read beam focussed onto the desired site is reflected as a function of the stored information, and the intensity of the reflected beam is detected by a detector in the read/write device 2.

The data storage medium may also be of an embodiment which cannot be written by the user. In this case, it contains information units written by the manufacturer. In this case, there is no need for a write function in the user's data drive.

In the polymer film 11, the information units are formed by changing the optical properties in a region having a preferred size of less than 1 μm . The information may be stored in binary form; i.e., the local reflectivity adopts only two values at the site of one information unit. In other words, if the reflectivity is above a fixed threshold value, a "1", for example, is stored at the site in question on the information carrier, and, if it is below this threshold value or below a different, lower threshold value, a "0" is correspondingly stored. It is, however, also conceivable for the information to be stored in a plurality of gray stages. This is possible if the reflectivity of the polymer film at the site of an information unit can be changed specifically by defined adjustment of the refractive index without saturation being reached.

Figure 2 illustrates a process step during the production of the data storage medium 1. The starting material is a polymer film made of biaxially oriented polypropylene, which is designated 30 here. On one side, the polymer film 30 has been provided with an adhesion layer 32 of acrylate adhesive. In order to

produce the spirallike structure of the information carrier, the polymer film 30 is laid against a cylindrical winding body 34, whose cross section can be seen in figure 2. The adhesion layer 32 faces outward.

5 The winding body 34 is then rotated until the polymer film 30 has been wound up fully with the adhesion layer 32. This produces the plies - designated 10 in figure 1 - of the polymer film 30, with the adhesion layer 32 forming the respective adhesion layers 12
10 between each pair of adjacent polymer film plies 10. Finally, the winding body 34 is withdrawn in the axial direction. Since the adhesion layer 32 faces outward during winding, there is no adhesion agent between the surface of the winding body 34 and the innermost
15 winding of the polymer film 30; otherwise, the withdrawal of the winding body 34 would be made more difficult.

Figure 3 shows the central area of the data storage medium 1 in a diagrammatic cross-sectional view. The
20 two inner windings of the polymer film 30 are shown, with the adhesion layer 32. For ease of illustration, the thicknesses of the polymer film 30 and of the adhesion layer 2 have been drawn in excessively large
25 in comparison to the diameter of the inner windings, and this applies in a similar way to figure 2 as well. Following the withdrawal of the winding body 34, a recess 36 is formed in the central region of the data storage medium 1, the periphery 37 of said recess 36
30 being formed by the innermost winding 38 of the polymer film 30. Accordingly, when the data storage medium 1 is used, there is, as illustrated by figure 1, no disruption by a winding core which would otherwise have to be penetrated once by a write beam emitted by the
35 read/write device 2 and twice, indeed, by a read beam emitted by the read/write device 2 and received following reflection. Furthermore, at the periphery 37 there is no adhesion material, which might, for example, have a tendency to become soiled.

When the polymer film 30 has been fully wound, the
adhesion layer 32 on the outside of the outermost
winding may be removed or covered, where necessary. It
5 is also conceivable to insert the finished wound body
into a sleeve in order to achieve better stability.

The form of the inner windings of the polymer film 30
as shown in figure 3 results when the film is wound
10 onto the cylindrical winding body 34 (see figure 2).
The fact that this form does not correspond to the
course of an ideal spiral is a result of the fact that,
at the beginning of the second winding, the polymer
film 30 has to be displaced radially outward in a more
15 or less abrupt way if it lies against the free end 39
of the polymer film 30. This deformation continues
outward, but affects the inner windings in particular.

Better results are achieved with a winding body 40 as
20 depicted in figure 4. The winding body 40 has, in cross
section, a spirallike outer contour 42 with a step 44
whose radial projection corresponds to the thickness of
the polymer film 30 plus the thickness of the adhesion
layer 32. As figure 4 illustrates, the spirallike outer
25 contour 42 guides the starting area of the second
winding of the polymer film 30 undisruptedly beyond the
area at the free end 39 of the polymer film 30 which
lies against the step 44, in the course of the winding
operation. Otherwise, the process illustrated by
30 figure 4 for producing a data storage medium 1 proceeds
in exactly the same way as the process elucidated in
connection with figure 2. As previously, the
representation according to figure 4 is also not to
scale. Following the withdrawal of the winding body 40,
35 the windings of the polymer film 30 run substantially
as in the case of an ideal spiral.

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